

4. ORGANIC CONTAMINANTS

Carbon tetrachloride, tetrachloroethene (PCE), and methylene chloride have been identified as contaminants of potential concern, primarily for the groundwater ingestion exposure pathway for OU 7-13/14. This section presents sampling results for those contaminants of potential concern followed by sampling results for other organics compounds detected during monitoring.

4.1 Carbon Tetrachloride

The primary source of CCl_4 at the SDA is Series 743 waste drums shipped from RFP between 1966 and 1970 (Miller and Varvel 2001). Initially, 9,691 Series 743 waste drums were buried in multiple pits in the SDA, including Pits 4, 5, 6, 9, 10, 11, and 12. In the 1970s, all 1,015 drums from Pits 11 and 12 were retrieved, leaving 8,676 drums of Series 743 waste drums in the SDA. The estimated mass of CCl_4 contained in these 8,676 drums is $8.2\text{E}+05$ kg (Miller and Varvel 2001).

Carbon tetrachloride has been detected at the SDA in surficial sediments, vadose zone soil gas, vadose zone soil water (perched water and lysimeters), and the aquifer beneath and surrounding the SDA. Carbon tetrachloride vapor also has been detected emanating from the soil surface by surface isolation flux chambers.

4.1.1 Waste Zone

Carbon tetrachloride was detected in high concentrations in soil-gas samples collected from vapor probes placed in the waste in Pits 4 and 10. The samples were collected in Tedlar bags or Summa canisters using a glovebox and analyzed with an INNOVA Model 1314 photoacoustic multigas analyzer. Some of the field duplicate samples also were analyzed using standard laboratory gas chromatography/mass spectrometry (GC/MS) as an accuracy check on the INNOVA results.

In FY 2003, carbon tetrachloride was detected in all of the probes that would yield a sample. The probes were sampled quarterly and seven or eight probes consistently produced a sample. During the last quarter of FY 2003, samples were obtained from five probes that had not previously yielded a sample. The success in obtaining samples from these previously unyielding probes is attributed to modifications to the glovebox and replacement of the line at the pump. However, the validity of the results from these five probes has been questioned and further sampling is necessary.

Table 4-1 contains results for CCl_4 and other VOCs for which analysis was performed. The maximum CCl_4 concentration measured was 55,080 ppmv at the 743-08-VP2 probe (4.1 m [13.4 ft] below land surface [bls]) in August 2003. Although this is down slightly from the FY 2002 maximum concentration, all results at this location are approaching the predicted equilibrium vapor concentration of CCl_4 in Series 743 sludge (46,000 at 10C) and close to the pure component equilibrium gas-concentration value (71,000 at 10C). This indicates the Series 743 sludge continues to be a source of CCl_4 and other VOCs. There was one higher concentration measured in a duplicate sample sent to the Southwest Laboratories of Oklahoma, but these results were J-flagged because of dilution and holding time issues.

During the last two quarters of FY 2003, there was a divergence in waste zone soil-gas sampling results between the INNOVA and the duplicate analyses performed using GC/MS. Up until this time, there was good agreement (<10%) between the INNOVA and the GC/MS. This issue currently is being

Table 4-1. Volatile organic compound vapor concentration results from Subsurface Disposal Area vapor probes in Fiscal Year 2003. All analyses were performed with the INNOVA gas analyzer except where noted. The Southwest Laboratory of Oklahoma and the Idaho National Engineering and Environmental Laboratory Environmental Chemistry Laboratory analyses were performed with gas chromatography/mass spectrometry.

Probe	Port Depth (ft)	Date Sampled	Sample No.	Carbon Tetrachloride (ppmv)	Chloroform (ppmv)	1,1,1-TCA ^b (ppmv)	TCE ^b (ppmv)	PCE ^b (ppmv)
743-03-VP1	19	8/4/03	IPV29101VA	169	35	9	47	14
743-03-VP2	14	8/4/03	IPV29201VA	82	20	5	17	8
743-03-VP3	5	8/4/03	IPV29301VA	1,011	246	50	26	-2
743-08-VP1	21	11/20/02	IPV17101VA	44,640	22,160 ^a	1,550	7,080	-192 ^b
		2/18/03	IPV20401VA	37,860	19,700	1,359	5,494	50
		5/21/03	IPV27001VA	45,360	20,670	1,585	8,494	-490 ^b
		5/21/03	IPV27001VT ^d	29,000	12,000	1,100 J	9,700	2,100 U
		8/6/03	IPV28601VA	50,370	21,670	1,701	9,116	-599 ^b
		8/6/03	IPV28601VT ^d	26,000	9,600	960	7,600	120 U
743-08-VP2	14	11/20/02	IPV17201VA	54,750	15,810	1,475	3,070	33
		11/20/02	IPV17201VT ^c	42,000 J	19,000 J	<1 R	4,900 J	1.4 J
		11/20/02	IPV17202VT ^c	61,000 J	22,000 J	1,900 J	5,300 J	<1 J
		11/20/02	IPV17202VA	54,460	15,300	1,459	2,944	33
		2/18/03	IPV20502VA	42,590	13,860	1,236	2,451	38
		2/18/03	IPV20501VT ^d	45,000	11,000	1,200	2,900	290 U
		2/18/03	IPV20502VT ^d	47,000	11,000	1,300	3,000	200 U
		5/20/03	IPV27101VA	45,700	14,340	1,308	3,100	48
		5/20/03	IPV27102VA	46,460	13,950	1,306	3,194	41
		8/6/03	IPV28701VA	55,080 ^a	15,600	1,488	3,607	54
		8/6/03	IPV28702VA	54,680	15,090	1,462	3,585	39
743-18-VP1	21	8/4/03	IPV29501VA	117	45	14	47	25
743-18-VP4	15	11/18/02	IPV17301VA	10,800	1,670	374	2,070	66
		5/20/03	IPV27201VA	7,567	1,218	249	1,467	58
		8/4/03	IPV28801VA	8,261	1,116	270	1,459	33
DU-08-VP2	16	11/18/02	IPV16601VA	12,670	8,185	3,793 ^a	8,863	1,963
		2/17/03	IPV19901VA	11,120	7,516	3,484	7,618	2,219
		5/21/03	IPV26501VA	10,170	6,826	3,167	6,096	1,664
		8/4/03	IPV28101VA	10,140	6,722	3,203	5,851	1,364
DU-10-VP2	11	11/18/02	IPV16701VA	6,220	1,890	2,220	4,160	2,070
		2/17/03	IPV20001VA	3,976	1,360	1,570	3,000	1,694
		5/21/03	IPV26601VA	3,657	1,499	1,471	2,656	1,374
		5/21/03	IPV26601VT ^d	2,400	540	1,100	2,100	750
		8/6/03	IPV28101VA	5,110	2,100	1,950	3,258	1,593
		8/6/03	IPV28201VT ^d	2,800	650	1,400	2,400	900

Table 4-1. (continued).

Probe	Port Depth (ft)	Date Sampled	Sample No.	Carbon Tetrachloride (ppmv)	Chloroform (ppmv)	1,1,1-TCA ^b (ppmv)	TCE ^b (ppmv)	PCE ^b (ppmv)
DU-10-VP3	7	11/18/02	IPV16801VA	10,200	1,570	1,880	2,870	2,160
		2/17/03	IPV20101VA	7,077	1,150	1,448	2,220	1,700
		5/21/03	IPV26701VA	7,069	1,194	1,568	2,252	1,593
		8/6/03	IPV28301VA	9,793	1,682	2,211	3,129	2,274 ^a
DU-14-VP1	17	8/4/03	IPV29001VA	221	133	71	174	93
DU-14-VP2	12	11/18/02	IPV16901VA	7,300	5,110	1,650	10,240 ^a	-52 ^b
		2/18/03	IPV20201VA	5,902	4,322	1,433	8,400	364
		5/21/03	IPV26801VA	5,833	4,270	1,325	7,935	209
		8/4/03	IPV28401VA	5,301	3,934	1,186	7,428	184
DU-14-VP3	5	11/18/02	IPV17001VA	840	571	449	1,020	546
		2/18/03	IPV20301VA	891	564	449	953	493
		5/21/03	IPV26901VA	1,108	793	562	1,257	552
		8/4/03	IPV28501VA	930	731	461	1,146	457

a. Maximum measured concentration excludes the J flag or estimated data.

b. Negative results are considered undetected.

c. The Southwest Laboratory of Oklahoma analyzed the 6-L Summa canister sample.

d. The Idaho National Engineering and Environmental Laboratory Environmental Chemistry Laboratory analyzed the 250-mL Summa canister sample.

PCE = tetrachloroethene

TCA = 1,1,1-trichloroethane

PCE = trichloroethene

investigated to determine the cause for the discrepancy. A plan will be prepared to correct the problem. The full set of results from all the probes is contained in the "Fiscal Year 2003 Summary Report for the OU 7-13/14 Probing Project (Draft).^f

Waste zone soil-moisture samples were not collected and analyzed for VOCs in FY 2003 because of arid conditions, limited sample volumes, and analytical priorities.

4.1.2 Vadose Zone

4.1.2.1 Perched Water and Lysimeter. Vadose zone soil-moisture samples were not collected and analyzed for VOCs in FY 2003 because of arid conditions, limited sample volumes, and analytical priorities. Lysimeter samples have not been collected and analyzed for VOCs since September 2000.

The USGS personnel collected a single perched water sample from Well USGS-92 on April 10, 2003. The CCl₄ concentration in that sample was 279 µg/L. Figure 4-1 shows the history of the CCl₄ concentrations in perched water in Well USGS-92. The decline in CCl₄ concentrations in Well USGS-92 is attributed to operation of the organic contamination in the vadose zone (OCVZ) vapor vacuum extraction with treatment (VVET) system. Well USGS-92 is located near the 7V vapor vacuum extraction well.

f. Meyers, Dennis R., Joel M. Hubbell, Nicholas Josten, L. Don Koeppen, Paul D. Ritter, Hopi Salomon, A. Jeffrey Sondrup, Deborah L. McElroy, and Carolyn W. Bishop, 2004, "Fiscal Year 2003 Summary Report for the OU 7-13/14 Probing Project (Draft)," ICP/EXT-04-00189, Rev. A, Idaho Completion Project, February 2004.

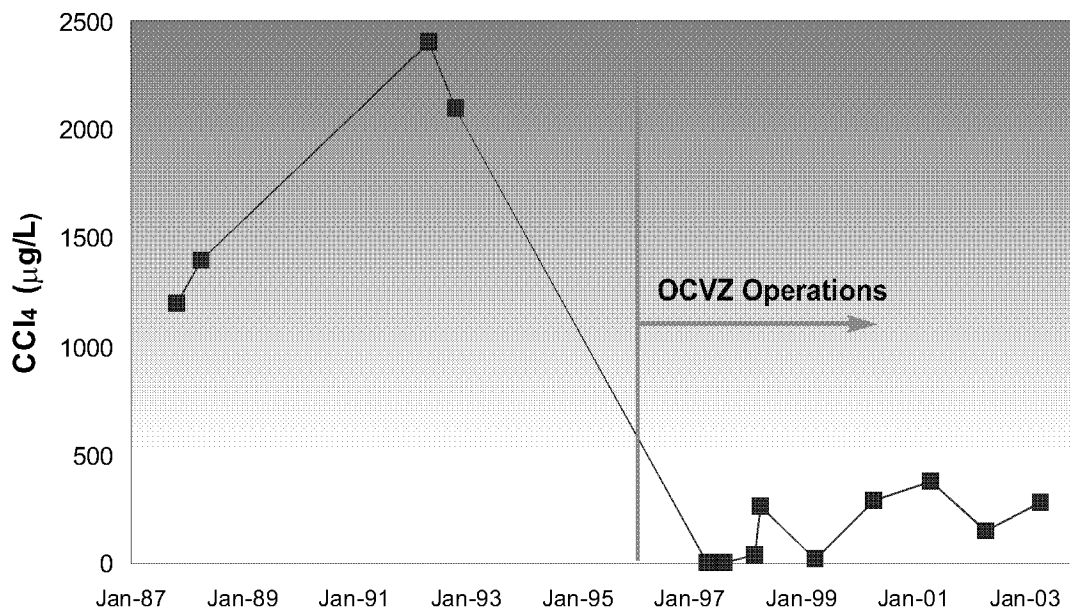


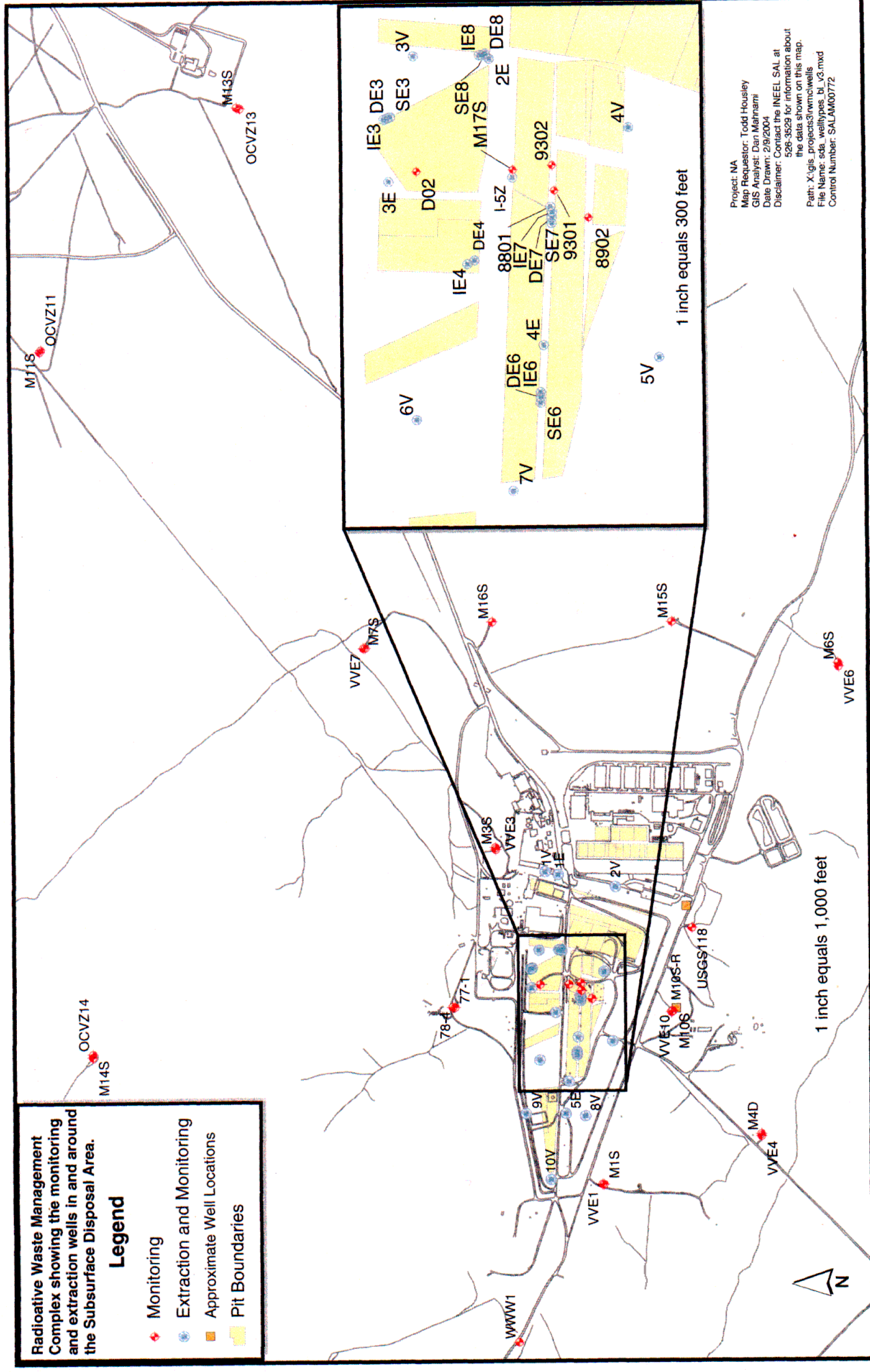
Figure 4-1. History of carbon tetrachloride concentration in Well USGS-92.

4.1.2.2 Soil Gas. Soil-gas monitoring in the vadose zone is accomplished using an extensive system of permanent soil-gas sampling ports inside and outside the SDA boundary. The ports are made of stainless-steel tubing attached to the outside of well casings. The bottom of the tubes are perforated and surrounded by sand. Figures 4-2a and 4-2b show the location of wells with soil-gas sampling ports in the vicinity of the SDA and the depths of the ports. The port depths range from a minimum depth of 4.6 m (15 ft) in Well WWW-1 to a maximum depth of 180.1 m (591 ft), just above the water table in Well M13S.

Hundreds of vadose zone soil-gas samples were collected in FY 2003. The complete set of soil-gas data can be found in the *Environmental and Operational Mid-Year Data Report for the OU 7-08 Organic Contamination in the Vadose Zone Project—2003* (Housley 2003) and the *Environmental and Operational End-Year Data Report for the OU 7-08 Organic Contamination in the Vadose Zone Project—2003* (Housley 2004). The highest levels of CCl₄ were located in the central portion of the SDA between Pits 4, 5, 6, and 10 and decrease with distance away from this area. Concentrations in the wells farthest from the SDA, OCVZ-11, and OCVZ-13 are less than 1 ppmv.

The maximum concentration measured in FY 2003 was 2,900 ppmv in Well 8801, Port 4 at a depth of 23.7 m (78 ft) on July 8, 2003. This is much less than the highest CCl₄ concentration ever measured, which was 4,864 ppmv in Well 9302, Port 6 at a depth of 23.5 m (77 ft) in January 1995. The maximum concentration in FY 2002 was 1,600 ppmv at the same location. The reason for the increase in FY 2003 likely results from the VVET units being shut down from June 12 to July 4, 2003, because of a power outage at the RWMC to install new cable and a transformer. Well 8801 is located approximately 80 ft from Vapor Extraction Well 8901D.

Vertically, the CCl₄ soil-gas contamination extends from land surface down to the water table. Currently, in the center of the SDA, the CCl₄ concentrations are 1,000 ppmv or higher above the B-C interbed. Concentrations then decrease sharply across the B-C interbed down to a few hundred ppmv. Below the C-D interbed, concentrations are generally less than 50 ppmv.



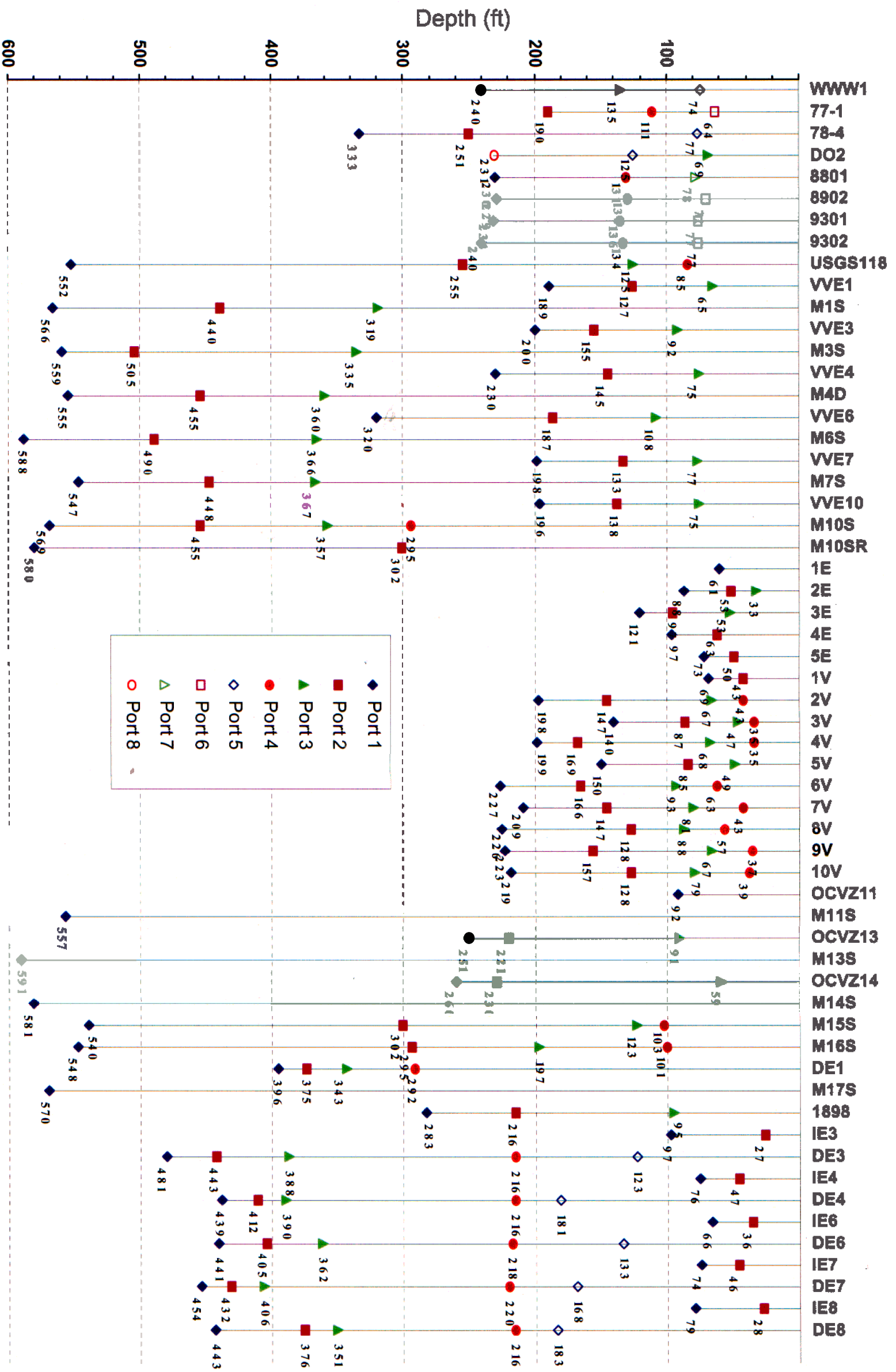


Figure 4-2b. Depth of the sampling ports in wells in the vicinity of the Radioactive Waste Management Complex.

Concentrations at most locations are much less now than before full-time operation of the OCVZ VVET system began in January 1996. Figures 4-3 and 4-4 show the soil-gas concentrations at two wells (8801 and 9301) near Vapor Extraction Well 8901D. In 1993, a treatability study was performed and soil-gas extraction from Well 8901D was performed for approximately 3 months. This event had little lasting impact on the concentration levels. Before 1996, the CCl_4 concentration at about the 23.5-m (77-ft) depth (above the B-C interbed) was approximately 3,000 ppmv in these two wells. However, after full-time extraction began in January 1996, the concentration dropped to about 1,000 ppmv. Near the 40-m (130-ft) depth below the B-C interbed, the concentration dropped from about 600 ppmv before vapor vacuum extraction operations to 100 ppmv after operations. Concentrations in the deeper ports, around 70 m (230 ft), appear to be unchanged by operations. In Well 9V (see Figure 4-5), the initial drop in concentration was not so dramatic, probably because it is located farther from an extraction well; however, the decrease has been steady. Even the deep gas port at 68 m (223 ft) shows a clear decline in concentrations.

In FY 2003, vadose zone soil-gas concentrations at several locations show an overall increase over FY 2002 levels. As shown in Figure 4-3, there was a large spike in the carbon tetrachloride soil-gas concentration in 8801-7 around July 2003. Although a serious outlier, the quality control data suggest that the number is valid. The standards for that day indicate that the instrument used for analyzing the 8801-7 sample was within 5% of the 1,000-ppm standard. The laboratory blank, analyzed just prior to the 8801-7 sample, contained 45 ppm carbon tetrachloride, which might have had a small but relatively insignificant contribution to the 919-ppmv reading in the sample from 8801-7. Part of the concentration rebound might be because VVET Unit A went down on June 12 and was not restarted until July 4. Samples were collected on July 7 and 8 and showed elevated carbon tetrachloride concentrations around Unit A, including 8801-7. Therefore, the conclusion for now is that it is an outlier and the validity will be determined by subsequent sampling.

During FY 2003, fourteen new vapor extraction wells were drilled and 10 of those wells have permanent vapor sampling ports. The locations of the new wells are shown in Figure 4-2a. The new well names begin with SE, IE, or DE signifying a Shallow (above the BC interbed), Intermediate (between the BC and CD interbeds), or DeeP (below the CD interbed) extraction well, respectively. Only the IE and DE wells have vapor sampling ports. The most interesting thing to note in the data from the new wells is that VOC concentrations below the CD interbed are higher than previously thought. Until FY 2003, the DE1 well was the only well inside the SDA with vapor ports below the CD interbed. The CCl_4 concentrations in DE1 were less than 10 ppmv. Concentrations in the newer DE wells have been as high as 60 ppmv. Plans are being made to analyze samples from these wells with something other than the B&K gas analyzer to confirm the high concentrations. Consequently, previous model results (Magnuson and Sondrup 1998) predicted concentrations directly below the CD interbed could be as high as 100 ppmv.

4.1.3 Aquifer

Eighty-eight aquifer samples were collected in FY 2003 from 22 monitoring wells in the vicinity of the RWMC and analyzed for VOCs. Sixty-two of the samples were collected by WAG 7 personnel from 15 monitoring wells and analyzed for CCl_4 . Thirty-three of those 62 samples had detections above the quantitation limit of 1 $\mu\text{g/L}$. Of those 33 detections, seven exceeded the primary drinking water MCL of 5 $\mu\text{g/L}$. Samples collected by WAG 7 were collected in November 2002 and February, April/May, and September 2003 from Monitoring Wells AllA31, M1S, M3S, M4D, M6S, M7S, M11S, M12S, M13S, M14S, M15S, M16S, M17S, OW2, and USGS-127. The WAG 7 results above the quantitation limit are summarized in Table 4-2.

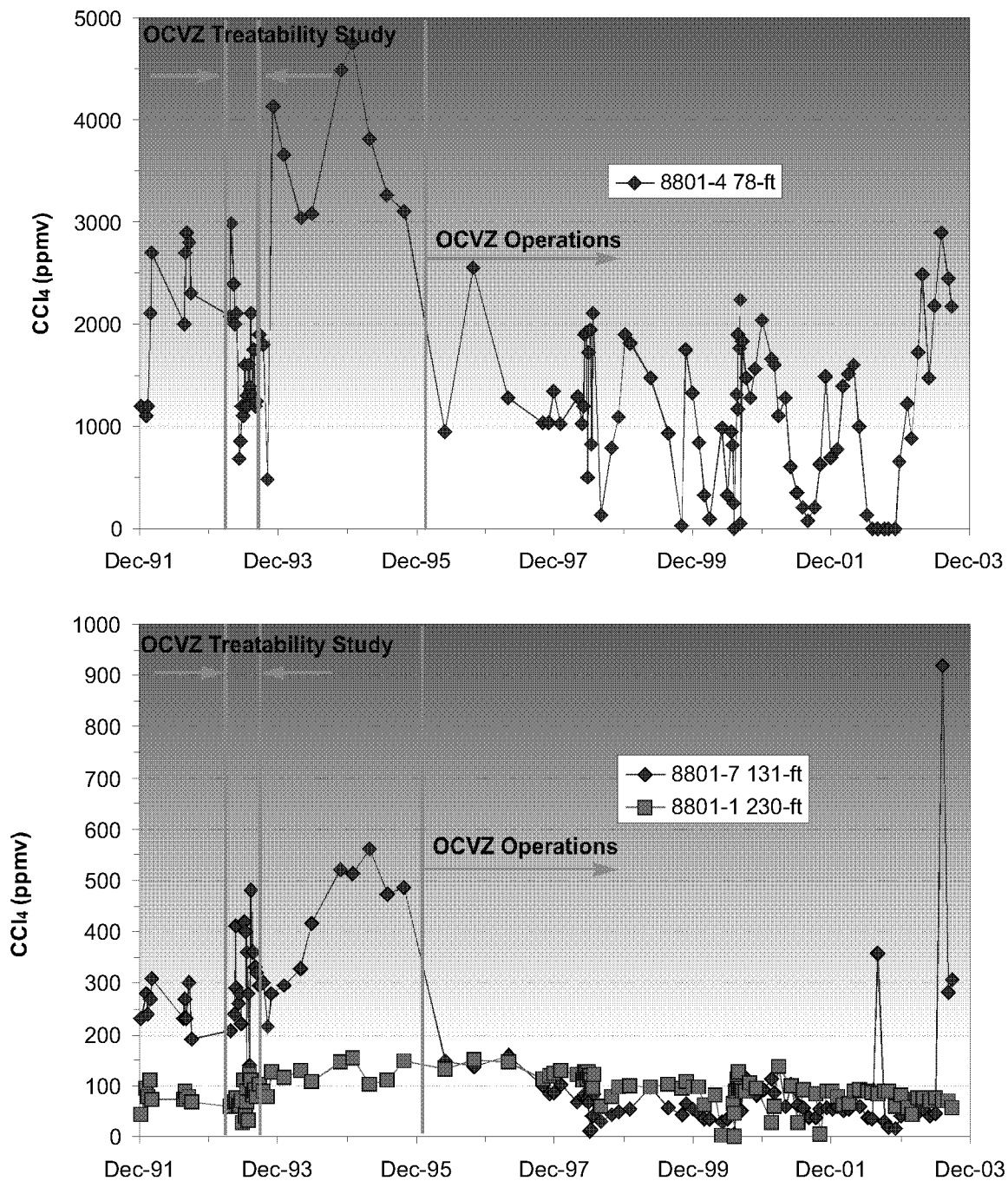


Figure 4-3. Carbon tetrachloride soil-gas concentration time history for selected ports in Well 8801.

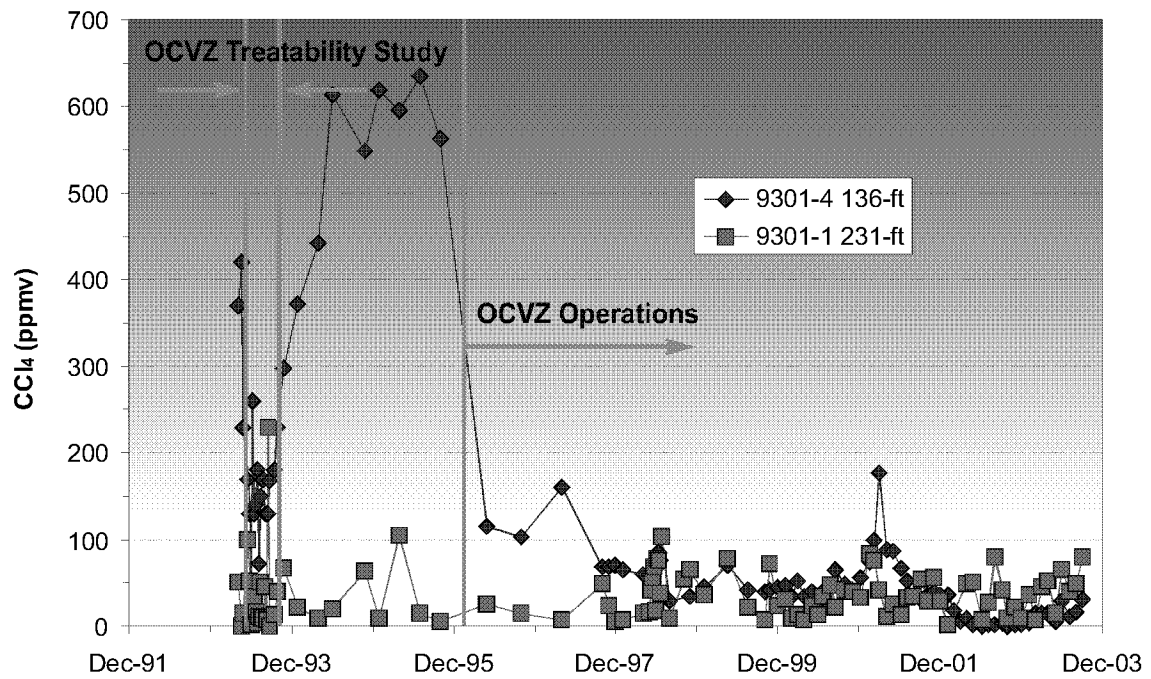
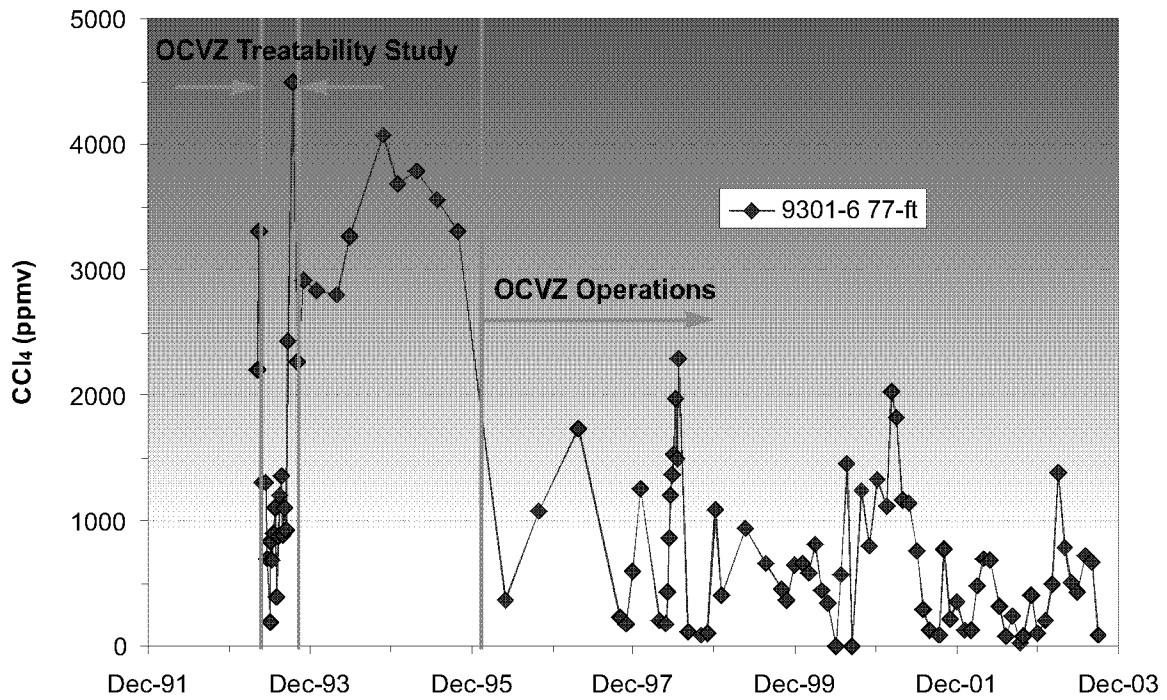


Figure 4-4. Carbon tetrachloride soil-gas concentration time history for selected ports in Well 9301.

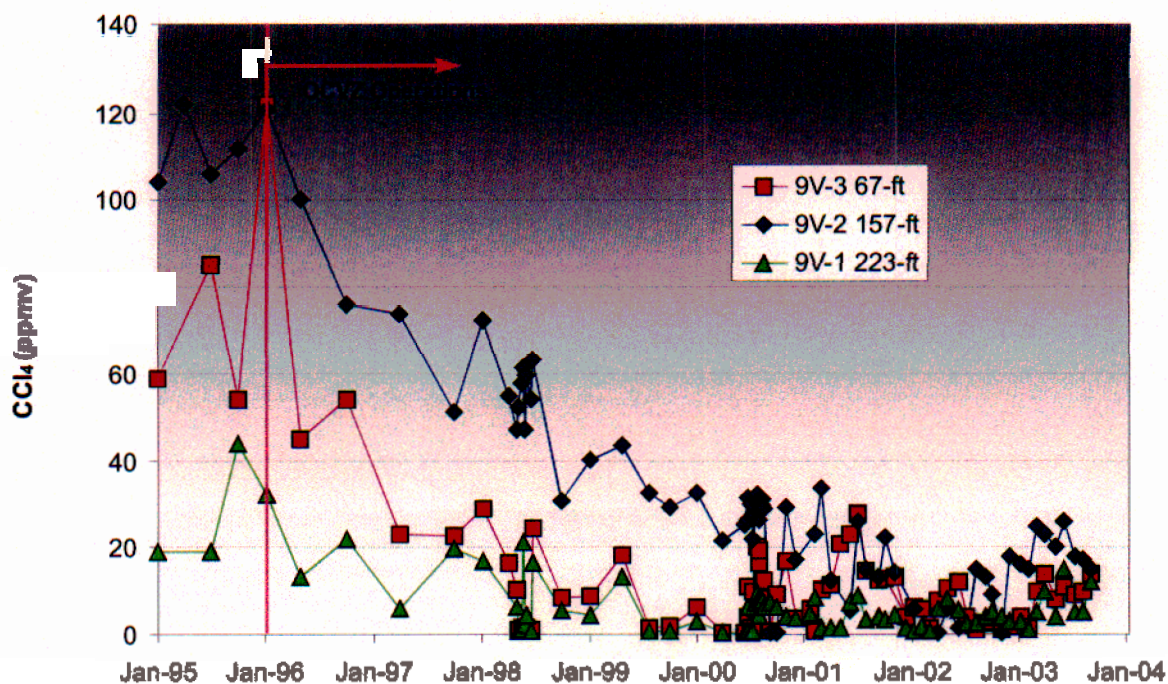


Figure 4-5. Carbon tetrachloride soil-gas concentration time history for selected ports in Well 9V.

Table 4-2. Carbon tetrachloride results above quantitation limit (Waste Area Group 7) or minimum reporting level in the aquifer in the vicinity of the Radioactive Waste Management Complex.

Well	Sample Date	Sample Concentration (µg/L)	Quantitation Limit or Minimum Reporting Level (µg/L)
Waste Area Group 7 Monitoring Results			
A11A31	11/05/02	5.5	1.0
M14S	11/05/02	1.2	1.0
M3S	11/05/02	2.1	1.0
M15S	11/06/02	1.3	1.0
M17S	11/06/02	2.2	1.0
M17S	11/06/02	2	1.0
M16S	11/11/02	4.6	1.0
M6S	11/11/02	2.2	1.0
OW2	11/11/02	0.55 ^b	1.0
M7S	11/12/02	5.5	1.0
A11A31	02/03/03	6	1.0
M6S	02/03/03	2	1.0
M7S	02/03/03	5	1.0
M15S	02/04/03	1	1.0
M16S	02/04/03	5	1.0
M17S	02/04/03	2	1.0
M14S	04/28/03	1 ^b	1.0

Table 4-2. (continued).

Well	Sample Date	Sample Concentration (µg/L)	Quantitation Limit or Minimum Reporting Level (µg/L)
M6S	04/28/03	2 _J ^b	1.0
M7S	04/29/03	6 _J ^b	1.0
A11A31	04/30/03	5 _J ^b	1.0
M16S	04/30/03	5 _J ^b	1.0
OW2	05/05/03	0.8 _J ^b	1.0
M15S	05/06/03	2	1.0
M3S	05/06/03	3	1.0
M17S	05/07/03	2	1.0
M17S	05/07/03	3	1.0
A11A31	08/04/03	7 _J ^b	1.0
M16S	08/04/03	7 _J ^b	1.0
M6S	08/04/03	4 _J ^b	1.0
M15S	08/05/03	2	1.0
M7S	08/05/03	8	1.0
M17S	08/06/03	2	1.0
M3S	08/06/03	3 _J ^b	1.0
United States Geological Survey Monitoring Results			
RWMC Production	10/10/02	4.8	0.2
RWMC Production	11/14/02	4.9	0.2
RWMC Production	12/12/02	5.5	0.2
RWMC Production	1/9/03	5.8	0.2
RWMC Production	2/13/03	4.4	0.2
RWMC Production	3/13/03	5.1	0.2
RWMC Production	4/10/03	5.6	0.2
RWMC Production	5/15/03	5.5	0.2
RWMC Production	6/12/03	5.6	0.2
RWMC Production	7/10/03	6.6	0.2
RWMC Production	8/14/03	6.3	0.2
RWMC Production	9/10/03	4	0.2
USGS-087	10/10/02	2.9	0.2
USGS-087	4/10/03	3.2	0.2
USGS-088	10/1/02	1.3	0.2
USGS-088	4/2/03	1.6	0.2
USGS-089	10/21/02	0.2	0.2
USGS-089	5/20/03	0.2	0.2
USGS-117	10/1/02	0.2	0.2
USGS-117	4/9/03	0.2	0.2
USGS-117	9/30/03	0.2	0.2

Table 4-2. (continued).

Well	Sample Date	Sample Concentration (µg/L)	Quantitation Limit or Minimum Reporting Level (µg/L)
USGS-119	10/3/02	0.2	0.2
USGS-119	4/7/03	0.2	0.2
USGS-119	9/30/03	0.2	0.2
USGS-120	10/10/02	3.4	0.2
USGS-120	4/10/03	3	0.2

a. **Red bold font** indicates sample concentrations that exceed the MCL.

b. Concentrations with a "J" subscript were positively identified in the sample and assigned a "J" data qualifier flag. The qualifier flag was assigned, because the recovery of one of the surrogates was slightly above the upper control limit. The reported concentrations might not be an accurate representation of the amount actually present in the sample and should only be used as estimated quantities.

MCL = maximum contaminant level

NA = not available

RWMC = Radioactive Waste Management Complex

USGS = United States Geological Survey

The USGS personnel collected 26 of the 88 aquifer samples from eight aquifer wells in the vicinity of the RWMC. Eighteen of the 26 samples had detections greater than or equal to the minimum reporting level of 0.2 µg/L. Of the 18 detections, eight met or exceeded the primary drinking water MCL of 5 µg/L, and, in comparison, six samples met or exceeded the primary drinking water MCL in FY 2002. Monthly, samples were collected by the USGS from the RWMC production well and in April and October 2003 from Wells USGS-87, USGS-88, USGS-89, USGS-117, USGS-119, and USGS-120. The USGS sample results greater than or equal to the minimum reporting level also are summarized in Table 4-2.

When FY 2003 WAG 7 and USGS results are combined, CCl₄ was consistently detected in 13 of 22 aquifer-monitoring wells. Concentrations in these wells varied from 0.2 to 8 µg/L, with four wells (A11A31, M7S, M16S, and RWMC production) exceeding the MCL. The nine wells where CCl₄ was not detected are M1S, M4D, M11S, M12S, M13S, USGS-89, USGS-117, USGS-119, and USGS-119. Wells M11S, M12S, M13S, and USGS-127 are more than 2.4 km (1.5 mi) from the SDA.

Figure 4-6 shows the concentration time history of CCl₄ in RWMC vicinity wells. Although concentrations have increased over the past several years, data from the last few years indicate a flat trend in most wells. Wells that exhibited an increasing trend during FY 2003 are M6S, M7S, M15S, M16S, and USGS-87. Wells that exhibited a decreasing trend during FY 2003 are M14S and USGS-120.

4.1.4 Summary of Carbon Tetrachloride

Carbon tetrachloride was detected in FY 2003 in waste zone soil gas, vadose zone soil gas, perched water, and in the aquifer in and around the RWMC. The highest soil-gas concentration was 55,080 ppmv, measured in the waste zone soil gas. The maximum soil-gas concentration outside the waste zone was 3,630 ppmv measured in Well 8801 Port 4 at 24 m (78 ft) bls. A single perched water sample contained 279 µg/L CCl₄. Carbon tetrachloride concentrations in vadose zone soil gas and perched water are appreciably lower since the OCVZ Project began operation of a VVET system.

In FY 2003, low levels of CCl₄ were consistently detected in aquifer-monitoring wells in and around the RWMC. The maximum concentration was 8 µg/L measured in Well M7S. The concentration exceeded the MCL of 5 µg/L in four wells (Wells A11A31, M7S, M16S, and the RWMC production well). Although concentrations have increased over the past several years, the data indicate a relatively flat trend in most wells during the past few years. The only well to exhibit an increasing trend over the past few years is Well A11A31, and the only well with a clearly decreasing trend over the past few years is Well USGS-120.

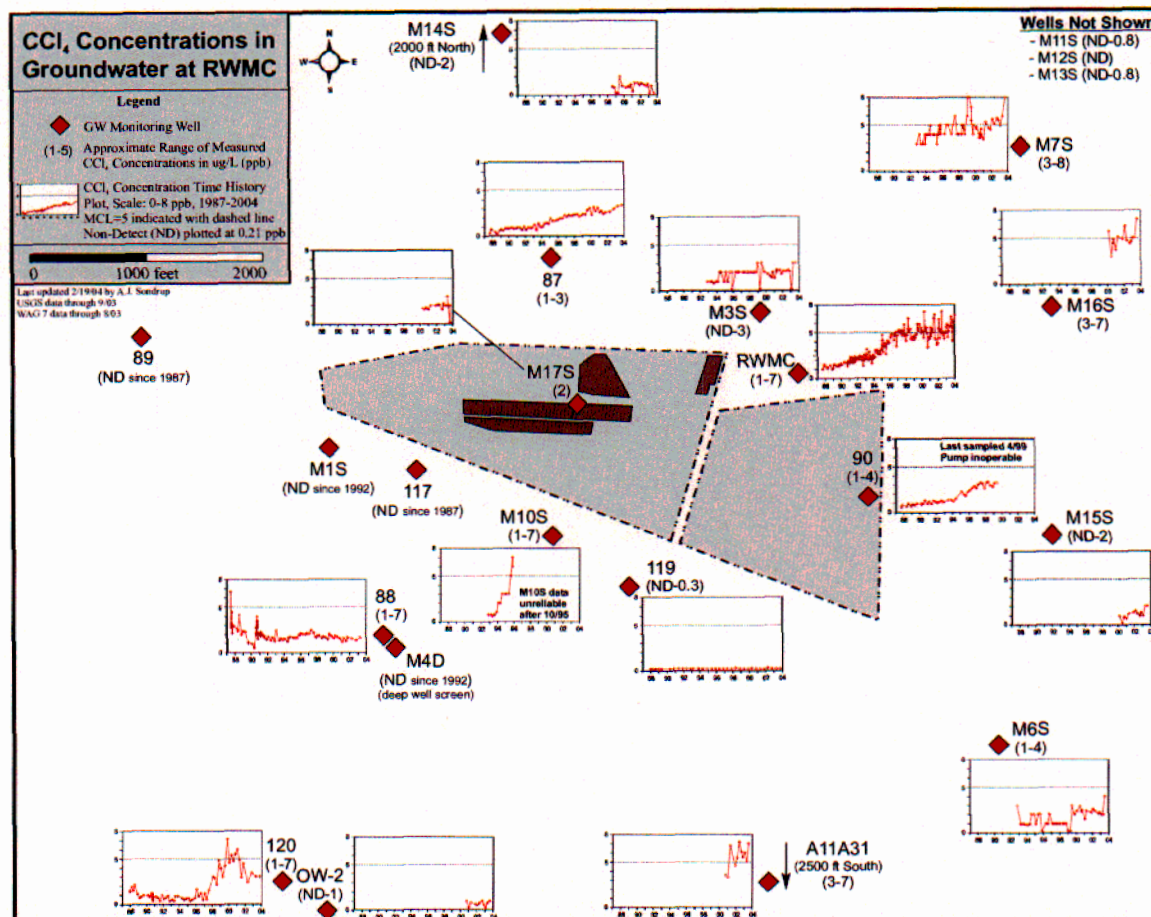


Figure 4-6. Carbon tetrachloride aquifer concentrations in monitoring wells in the vicinity of the Radioactive Waste Management Complex.

4.2 Tetrachloroethene

The primary source of PCE at the SDA is Series 743 waste. The estimated mass of PCE contained in Series 743 sludge is $9.8\text{E}+04$ kg (Varvel 2001).

Tetrachloroethene has been detected at the SDA in surficial sediments, vadose zone soil gas, vadose zone soil water (perched water and lysimeters), and groundwater. Tetrachloroethene vapor also has been detected emanating from the soil surface by surface isolation flux chambers.

4.2.1 Waste Zone

Tetrachloroethene was detected in high concentration in gas samples collected from vapor probes placed in the waste in Pits 4 and 10. The samples were collected in Tedlar bags or Summa canisters using a glovebox and analyzed with an INNOVA Model 1314 photoacoustic multigas analyzer. Some of the field duplicate samples also were analyzed using standard laboratory GC/MS as an accuracy check on the INNOVA results.

Tetrachloroethene was detected in all but one of the probes that would yield a vapor sample. Table 4-1 contains the PCE results as well as results for the other gases for which analyses were

performed. The highest concentrations of PCE are in the DU Focus Area in the west end of Pit 10. The PCE concentrations in the 743 Focus Area are typically less than 50 ppmv, while concentrations in the DU Focus Area range from a few hundred ppmv to over 2,000 ppmv. The maximum PCE concentration measured was 2,274 ppmv at the DU-10-VP3 location (1.9 m [6.2 ft] bls) in August 2003. This is slightly less than the maximum concentration measured last year, but is still greater than the estimated equilibrium vapor concentration of CCl₄ in Series 743 sludge (750 ppmv at 10C). However, the equilibrium vapor concentration for PCE is small, because PCE is estimated to be a small fraction of the VOC components in Series 743 sludge. Nevertheless, results indicate that Series 743 sludge continues to be a source of PCE and other VOCs. The full set of results from all the probes is contained in the "Fiscal Year 2003 Summary Report for the OU 7-13/14 Probing Project (Draft)" (see footnote f).

Waste zone soil-moisture samples were not collected and analyzed for VOCs in FY 2003 because of arid conditions, limited sample volumes, and analytical priorities.

4.2.2 Vadose Zone

4.2.2.1 Perched Water and Lysimeter. Vadose zone soil-moisture samples were not collected and analyzed for VOCs in FY 2003 because of arid conditions, limited sample volumes, and analytical priorities. Lysimeter samples have not been collected and analyzed for VOCs since September 2000.

The USGS personnel collected a single perched water sample from Well USGS-92 on April 10, 2003. The PCE concentration in that sample was 39.5 µg/L. Tetrachloroethene has consistently been detected in Well USGS-92 since 1987. The maximum concentration measured was 180 µg/L on February 29, 1996, and the minimum was 23 µg/L on March 30, 1999. Since the OCVZ Project began operating the VVET system, PCE concentrations have declined in USGS-92.

4.2.2.2 Soil Gas. Tetrachloroethene has consistently been detected in soil gas at the RWMC for several years, but at much lower concentrations than CCl₄. Before FY 2002, the historic maximum PCE concentration was 135 ppmv in Well 8902, Port 4 at a depth of 39 m (130 ft) on January 4, 1996. Since April 1998, the PCE concentrations in Well 8902, Port 4 have been less than 10 ppmv. Concentrations at other wells inside the SDA have generally been less than 20 ppmv. Inside the SDA, below the C-D interbed, concentrations have been less than 2 ppmv. Outside the SDA, the historic maximum PCE concentration measured was 75 ppmv in Well 77-1, Port 2 at a depth of 58 m (190 ft). Concentrations in this port now are generally less than 30 ppmv. Outside the SDA, below the C-D interbed, concentrations are generally less than 1 ppmv.

Since June 2002, there have been several anomalously high PCE measurements. They have almost exclusively occurred at Wells 77-1 and 78-4. Sulfur hexafluoride (SF₆) gas was used for a gas tracer test in these two wells and it appears that the SF₆ interferes with the PCE filter on the B&K gas analyzer. The number of anomalous readings has decreased but still persists in FY 2003. The maximum PCE concentration in soil gas in FY 2003 was 179 ppmv in Well 77-1, Port 4 at a depth of 32 m (104 ft) on November 4, 2002. Typical concentrations in this port are less than 20, so it likely that the SF₆ interference still persists.

4.2.3 Aquifer

Eighty-eight aquifer samples were collected in FY 2003 from 22 monitoring wells in the vicinity of the RWMC and analyzed for VOCs. Sixty-two of the samples were collected by WAG 7 personnel in November 2002 and February, April/May, and September 2003 from Monitoring Wells A1A31, M1S, M3S, M4D, M6S, M7S, M11S, M12S, M13S, M14S, M15S, M16S, M17S, OW2, and USGS-127. None of the 62 samples had detections above the quantitation limit of 1 µg/L.

Twenty-six of the 88 aquifer samples were collected by USGS personnel from eight aquifer wells in the vicinity of the RWMC. Samples were collected by the USGS monthly from the RWMC production well and in April and October 2003 from Wells USGS-87, USGS-88, USGS-89, USGS-117, USGS-119, USGS-120, and USGS-127. Only one of the 26 samples had detection greater than or equal to the minimum reporting level of 0.2 µg/L, and it was 0.3 µg/L in the RWMC production well in August 2003.

Positive detections of PCE in SDA-vicinity aquifer wells are infrequent. The historical maximum PCE concentration measured was 0.4 µg/L in Well M7S on five different occasions from 1993 to 1996. This is well below the MCL of 5 µg/L.

4.2.4 Summary of Tetrachloroethene

Tetrachloroethene was detected in FY 2003 in waste zone soil gas, vadose zone soil gas, perched water, and in the aquifer in the vicinity of the RWMC. The maximum soil-gas concentration was 2,274 ppmv measured in the waste zone soil gas. Vadose zone soil-gas concentrations measured in FY 2003 are typical except for a few anomalously high measurements likely due to interference from a tracer gas (SF₆) used in 2002. A single perched water sample contained 39.5 µg/L of PCE. Tetrachloroethene was detected in only one of 88 aquifer samples. It was detected in the RWMC production well at 0.3 µg/L, which is just about above the minimum reporting level of 0.2 µg/L.

4.3 Methylene Chloride

Approximately 1.4E+04 kg of methylene chloride was disposed of in the SDA (Holdren et al. 2002). Information about methylene chloride disposal is scant compared to that for other, more prevalent VOCs like CCl₄. It should be noted that CCl₄ could degrade to methylene chloride; thus, considering the large mass of CCl₄ buried in the SDA, detections of methylene chloride in samples might not necessarily be related to the original inventory disposed of in the SDA.

4.3.1 Waste Zone

Only the duplicate gas samples from the soil vapor probes in the waste zone that are sent to a laboratory are analyzed for methylene chloride. In FY 2003, methylene chloride was identified above the method detection limit in five of eight samples from three different probes. However, only two of those results were above the practical quantitation limit (no J-flag). The maximum concentration was 710 ppmv on August 6, 2003, at Probe 743-08-VP1 at a depth of 6.4 m (21 ft). The results are shown in Table 4-3.

Waste zone soil-moisture samples were not collected and analyzed for VOCs in FY 2003 because of arid conditions, limited sample volumes, and analytical priorities.

4.3.2 Vadose Zone

4.3.2.1 Perched Water and Lysimeter. Vadose zone soil-moisture samples were not collected and analyzed for VOCs in FY 2003 because of arid conditions, limited sample volumes, and analytical priorities. Lysimeter samples have not been collected and analyzed for VOCs since September 2000.

The USGS personnel collected a single perched water sample from Well USGS-92 on April 10, 2003. The methylene chloride concentration in that sample was less than the reporting limit of 0.2 µg/L. The perched water sample from Well USGS-92 in April 2002 was 4.7 µg/L for comparison. Methylene chloride has been consistently detected in Well USGS-92 since April 1997. Before that, it was analyzed for but not detected above the minimum reporting level of 0.2 µg/L. The maximum methylene chloride concentration in perched water from Well USGS-92 was 22.4 µg/L on April 17, 2001.

Table 4-3. Fiscal Year 2003 methylene chloride vapor concentration results from Subsurface Disposal Area soil vapor probes.

Probe	Port Depth (ft)	Date Sampled	Sample No.	Laboratory	Methylene Chloride (ppmv)
743-08-VP1	21	5/21/03	IPV27001VT	Southwest Laboratory of Oklahoma	730 J
		8/6/03	IPV28601VT	Southwest Laboratory of Oklahoma	710
743-08-VP2	14	11/20/02	IPV17201VT	Environmental Chemistry Laboratory	550 J
		11/20/02	IPV17202VT	Environmental Chemistry Laboratory	<1 U
		2/18/03	IPV20501VT	Environmental Chemistry Laboratory	420 U
		2/18/03	IPV20502VT	Environmental Chemistry Laboratory	500
DU-10-VP2	11	5/21/03	IPV26601VT	Environmental Chemistry Laboratory	27 J
		8/6/03	IPV28201VT	Environmental Chemistry Laboratory	65 U

4.3.2.2 Soil Gas. No soil gas samples collected in FY 2002 or 2003 from the vadose zone vapor sampling ports were analyzed for methylene chloride. However, of the hundreds of samples collected prior to FY 2002 and analyzed for methylene chloride, only five returned positive detections and the concentrations were relatively low compared to other VOCs (e.g., CCl₄, trichloroethene [TCE], and PCE).

4.3.3 Aquifer

Eighty-eight aquifer samples were collected in FY 2003 from 22 monitoring wells in the vicinity of the RWMC and analyzed for VOCs. Sixty-two of the samples were collected by WAG 7 personnel in November 2002 and February, April/May, and September 2003 from Monitoring Wells A1A31, M1S, M3S, M4D, M6S, M7S, M11S, M12S, M13S, M14S, M15S, M16S, M17S, OW2, and USGS-127. Only one of the 62 samples had detection above the quantitation limit of 1 µg/L. Methylene chloride was reported at 2.8 µg/L in Well M1S in November 2002, but it was also detected in the associated blank.

The USGS personnel collected 26 of the 88 aquifer samples from eight aquifer wells in the vicinity of the RWMC. Samples were collected by the USGS monthly from the RWMC production well and in April and October 2003 from Wells USGS-87, USGS-88, USGS-89, USGS-117, USGS-119, USGS-120, and USGS-127. None of the 26 samples had detection greater than or equal to the minimum reporting level of 0.2 µg/L.

Positive detections of methylene chloride in SDA-vicinity aquifer wells are infrequent. The historical maximum methylene chloride concentration measured was 8 µg/L in Well M10S, collected on July 22, 1996, which is greater than the MCL of 5 µg/L. However, five of the total seven detections historically were during the same sampling round (July 1996), which raises the question whether the samples were cross-contaminated before or during analysis. Except for the sample in M1S in November 2002, which was also detected in the associated blank, methylene chloride has not been detected in any aquifer wells since October 1997.

4.3.4 Summary of Methylene Chloride

Methylene chloride was detected in soil vapor samples taken from vapor probes in the waste zone. The maximum concentration was 710 ppmv. Methylene chloride was not detected in a single perched water sample collected from Well USGS-92 in FY 2003. Soil gas was not analyzed for methylene

chloride, and of 88 aquifer samples, methylene chloride was detected only once, but it was also detected in the associated blank.

4.4 Other Organic Contaminants

4.4.1 Waste Zone

Besides CCl₄ and PCE, gas samples collected from vapor probes placed in the waste in Pits 4 and 10 were analyzed for TCE, 1,1,1-trichloroethane (1,1,1-TCA), and chloroform using an INNOVA Model 1314 photoacoustic multigas analyzer. Some of the field duplicate samples also were analyzed using standard laboratory GC/MS (EPA 1999) as an accuracy check on the INNOVA results. The GC/MS analyzed for several other VOCs.

Trichloroethene, 1,1,1-TCA, and chloroform were detected in all of the vapor probes that would yield a vapor sample. Other VOCs detected in the samples analyzed by GC/MS include chloroethane (J-flag), chloromethane, 1,1-dichloroethane, and 1,1,2-trichloro-1,2,2-trifluoroethane (Freon-113). Table 4-4 shows the maximum results for each of the other organics identified in the vapor probes samples.

Table 4-4. Maximum concentrations of trichloroethene, 1,1,1-trichloroethane, chloroform, and Freon-113 detected in soil gas from waste zone vapor probes.

Organic Compound	Sample Date	Well Port	Depth (ft)	Concentration (ppmv)
Trichloroethene	11/18/02	DU-14-VP2	12	10,240
1,1,1-Trichloroethane	11/18/02	DU-08-VP2	16	3793
Chloroform	11/20/02	743-08-VP1	21	22,160
Chloromethane	8/6/03	743-08-VP1	21	950
Freon-113	8/6/03	743-08-VP1	21	180
1,1-Dichloroethane	8/6/03	DU-10-VP2	11	35

No waste zone soil-moisture samples were collected and analyzed for VOCs in FY 2003 because of arid conditions, limited sample volumes, and analytical priorities.

4.4.2 Vadose Zone

4.4.2.1 Perched Water and Lysimeter. Vadose zone soil-moisture samples were not collected and analyzed for VOCs in FY 2003, because of arid conditions, limited sample volumes, and analytical priorities. Lysimeter samples have not been collected and analyzed for VOCs since September 2000.

The USGS personnel collected a single perched water sample from Well USGS-92 on April 11, 2003. The concentrations of other organics besides CCl₄, PCE, and methylene chloride in that sample are shown in Table 4-5.

4.4.2.2 Soil Gas. Trichloroethene, 1,1,1-TCA, and chloroform are the only other VOCs for which analysis is performed on vadose zone soil-gas samples collected at the SDA. All three compounds are ubiquitous in the vicinity of the RWMC, but at much lower concentrations than CCl₄. The complete set of soil-gas data is presented in the *Environmental and Operational Mid-Year Data Report for the OU 7-08 Organic Contamination in the Vadose Zone Project—2003* (Housley 2003) and *Environmental and Operational End-Year Data Report for the OU 7-08 Organic Contamination in the Vadose Zone Project—2003* (Housley 2004).

Table 4-5. Concentrations of other organic compounds detected in a perched water sample from Well USGS-92 in Fiscal Year 2003.

Organic Compound	Fiscal Year 2003 Concentration (µg/L)	Fiscal Year 2002 Concentration for Comparison (µg/L)	Maximum Contaminant Level (µg/L)
Chloroform	256	236	100
1,1,1-Trichloroethane	30	22	200
Trichloroethene	232	198	5

The maximum concentrations detected in FY 2003 both inside and outside the SDA are shown in Table 4-6. The maximum concentrations detected historically both inside and outside the SDA are shown in Table 4-7.

Table 4-6. Maximum concentrations of trichloroethene, 1,1,1-trichloroethane, and chloroform detected in vadose zone soil gas inside and outside the Subsurface Disposal Area in Fiscal Year 2003.

Organic Compound	Inside or Outside the Subsurface Disposal Area	Sample Date	Well Port	Depth (ft)	Concentration (ppmv)
Trichloroethene	Inside	4/1/03	8801-4	78	591
1,1,1-Trichloroethane	Inside	7/8/03	IE7-1	74	187
Chloroform	Inside	7/8/03	8801-4	78	898
Trichloroethene	Outside	4/1/03	1V-1	69	18
1,1,1-Trichloroethane	Outside	9/2/03	77-1-4	111	14
Chloroform	Outside	9/2/03	77-1-4	111	12

Table 4-7. Historic maximum concentrations of trichloroethene, 1,1,1-trichloroethane, and chloroform detected in vadose zone soil gas inside and outside the Subsurface Disposal Area.

Organic Compound	Inside or Outside the Subsurface Disposal Area	Sample Date	Well Port	Depth (ft)	Concentration (ppmv)
Trichloroethene	Inside	5/00	9301-6	77	5,539
1,1,1-Trichloroethane	Inside	1/96	8801-4	78	199
Chloroform	Inside	1/96	8801-4	78	1,160
Trichloroethene	Outside	3/01	VVE10-3	75	28
1,1,1-Trichloroethane	Outside	1/99	M7S-2	448	501
Chloroform	Outside	4/94	VVE10-3	75	25

4.4.3 Aquifer

In addition to CCl₄, PCE, and methylene chloride, RWMC aquifer samples in FY 2003 were analyzed for other VOCs and most were nondetections. Chloroform, TCE, toluene, and 1,1,1-TCA were the only compounds detected at concentrations above the quantitation limit (WAG 7) or minimum reporting level (USGS). All compounds were below the respective MCLs (see Table 4-8).

Table 4-8. Concentration of volatile organic compounds detected in the aquifer in the vicinity of the Radioactive Waste Management Complex in Fiscal Year 2003.

Organic Compound	Sample Date	Well	Sample Concentration (µg/L)	Quantitation Limit or Minimum Reporting Level (µg/L)	MCL (µg/L)
Waste Area Group 7 Monitoring Results					
Chloroform	A11A31	11/05/02	1.1	1.0	100
Chloroform	A11A31	02/03/03	1	1.0	100
Chloroform	A11A31	04/30/03	1	1.0	100
Chloroform	A11A31	08/04/03	1	1.0	100
Trichloroethene	A11A31	11/05/02	2.3	1.0	5
Trichloroethene	M16S	11/11/02	1.9	1.0	5
Trichloroethene	M7S	11/12/02	2	1.0	5
Trichloroethene	A11A31	02/03/03	2	1.0	5
Trichloroethene	M7S	02/03/03	2	1.0	5
Trichloroethene	M16S	02/04/03	2	1.0	5
Trichloroethene	M7S	04/29/03	2	1.0	5
Trichloroethene	A11A31	04/30/03	3	1.0	5
Trichloroethene	M16S	04/30/03	2	1.0	5
Trichloroethene	A11A31	08/04/03	2	1.0	5
Trichloroethene	M16S	08/04/03	2	1.0	5
Trichloroethene	M7S	08/05/03	3	1.0	5
Trichloroethene	A11A31	11/05/02	2.3	1.0	5
Trichloroethene	M16S	11/11/02	1.9	1.0	5
Trichloroethene	M7S	11/12/02	2	1.0	5
Trichloroethene	A11A31	02/03/03	2	1.0	5
Trichloroethene	M7S	02/03/03	2	1.0	5
Trichloroethene	M16S	02/04/03	2	1.0	5
Toluene	A11A31	02/03/03	29	1.0	1,000
Toluene	M7S	02/03/03	2	1.0	1,000
Toluene	M7S	04/29/03	7	1.0	1,000
Toluene	A11A31	04/30/03	47	1.0	1,000
Toluene	A11A31	08/04/03	2	1.0	1,000
Toluene	M7S	08/05/03	5	1.0	1,000
Toluene	A11A31	02/03/03	29	1.0	1,000
Toluene	M7S	02/03/03	2	1.0	1,000
United States Geological Survey Monitoring Results					
Chloroform	RWMC	10/10/02	0.9	0.2	100
Chloroform	RWMC	11/14/02	1.7	0.2	100
Chloroform	RWMC	12/12/02	1	0.2	100
Chloroform	RWMC	1/9/03	1.3	0.2	100
Chloroform	RWMC	2/13/03	0.9	0.2	100
Chloroform	RWMC	3/13/03	0.9	0.2	100
Chloroform	RWMC	4/10/03	1.1	0.2	100
Chloroform	RWMC	5/15/03	1.1	0.2	100
Chloroform	RWMC	6/12/03	1.1	0.2	100
Chloroform	RWMC	7/10/03	1.2	0.2	100
Chloroform	RWMC	8/14/03	1.3	0.2	100

Table 4-8. (continued).

Organic Compound	Sample Date	Well	Sample Concentration (µg/L)	Quantitation Limit or Minimum Reporting Level (µg/L)	MCL (µg/L)
Chloroform	RWMC	9/10/03	0.8	0.2	100
Chloroform	USGS-87	10/10/02	0.1	0.2	100
Chloroform	USGS-87	4/10/03	0.2	0.2	100
Chloroform	USGS-88	10/1/02	0.4	0.2	100
Chloroform	USGS-88	4/2/03	0.4	0.2	100
Chloroform	USGS-120	10/10/02	0.6	0.2	100
Chloroform	USGS-120	4/10/03	0.5	0.2	100
1,1,1-TCA	RWMC	10/10/02	0.4	0.2	200
1,1,1-TCA	RWMC	11/14/02	0.5	0.2	200
1,1,1-TCA	RWMC	12/12/02	0.5	0.2	200
1,1,1-TCA	RWMC	1/9/03	0.5	0.2	200
1,1,1-TCA	RWMC	2/13/03	0.4	0.2	200
1,1,1-TCA	RWMC	3/13/03	0.4	0.2	200
1,1,1-TCA	RWMC	4/10/03	0.5	0.2	200
1,1,1-TCA	RWMC	5/15/03	0.5	0.2	200
1,1,1-TCA	RWMC	6/12/03	0.5	0.2	200
1,1,1-TCA	RWMC	7/10/03	0.6	0.2	200
1,1,1-TCA	RWMC	8/14/03	0.5	0.2	200
1,1,1-TCA	RWMC	9/10/03	0.4	0.2	200
1,1,1-TCA	USGS-87	10/10/02	0.2	0.2	200
1,1,1-TCA	USGS-87	4/10/03	0.2	0.2	200
1,1,1-TCA	USGS-120	10/10/02	0.3	0.2	200
1,1,1-TCA	USGS-120	4/10/03	0.2	0.2	200
Trichloroethene	RWMC	10/10/02	2.1	0.2	5
Trichloroethene	RWMC	11/14/02	2.2	0.2	5
Trichloroethene	RWMC	12/12/02	2.4	0.2	5
Trichloroethene	RWMC	1/9/03	2.4	0.2	5
Trichloroethene	RWMC	2/13/03	2.1	0.2	5
Trichloroethene	RWMC	3/13/03	2.3	0.2	5
Trichloroethene	RWMC	4/10/03	2.6	0.2	5
Trichloroethene	RWMC	5/15/03	2.7	0.2	5
Trichloroethene	RWMC	6/12/03	2.4	0.2	5
Trichloroethene	RWMC	7/10/03	2.7	0.2	5
Trichloroethene	RWMC	8/14/03	2.8	0.2	5
Trichloroethene	RWMC	9/10/03	1.8	0.2	5
Trichloroethene	USGS-87	10/10/02	0.7	0.2	5
Trichloroethene	USGS-87	4/10/03	0.7	0.2	5
Trichloroethene	USGS-88	10/1/02	0.6	0.2	5
Trichloroethene	USGS-88	4/2/03	0.6	0.2	5
Trichloroethene	USGS-120	10/10/02	1.1	0.2	5
Trichloroethene	USGS-120	4/10/03	0.9	0.2	5

MCL = maximum contaminant level
RWMC = Radioactive Waste Management Complex

1,1,1-TCA = 1,1,1-trichloroethane
USGS = United States Geological Survey

Chloroform was detected in Wells A11A31, RWMC, USGS-87, USGS-88, USGS-120, and the maximum concentration was 1.7 µg/L. Trichloroethene was detected in Wells M7S, M16S, A11A31, RWMC, USGS-87, USGS-88, and USGS-120, and the maximum concentration was 3. 1,1,1-Trichloroethane was detected in the RWMC production well and Wells USGS-87 and USGS-120. The maximum 1,1,1-trichloroethane concentration was 0.6 µg/L. Toluene was detected consistently in Wells M7S and A11A31, and the maximum concentration was 47 µg/L. Samples were analyzed for 54 other organic compounds, but none were detected above the quantitation limit (WAG 7) or minimum reporting level (USGS).

4.4.4 Summary

Other organics detected during sampling at the RWMC include TCE, 1,1,1-TCA, chloroform, Freon-113, 1,1-dichloroethane, chloromethane, and toluene. All organics, except for toluene, were detected in waste zone soil gas. The concentrations of chloroform and TCE were down slightly from FY 2002 values.

A single perched water sample contained TCE, 1,1,1-TCA, and chloroform. These concentrations are appreciably less than before operation of the OCVZ VVET system began in 1996. During aquifer monitoring in FY 2003, only four other organic compounds (i.e., TCE, 1,1,1-TCA, chloroform, and toluene) were detected in 88 samples. All sample results were below MCLs. Toluene had the highest concentration (47 µg/L) in Well A11A31, followed by TCE (3 µg/L) in Wells A11A31 and M7S. The maximum chloroform concentration was 1.7 µg/L, and the maximum 1,1,1-TCA concentration was 0.6 µg/L, both in the RWMC production well.

Detections of TCE and 1,1,1-TCA are not surprising, because those were components of Series 743 sludge. Chloroform detections also are not surprising, because it is likely being produced by degradation of the CCl₄. Detections of the other organics like Freon-113, 1,1-dichloroethane (soil gas), and toluene (groundwater) are low-level detections and will continue to be monitored.

